



# **QA-301 COMPACT DISC ANALYZER**

*OPERATING MANUAL*

**Version 3.77**



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# INTRODUCTION

The Clover Systems QA-301 Compact Disc Analyzer is a versatile tool for the production line evaluation of compact discs. Its primary purpose is to verify the condition of new stampers, and to detect and anticipate process problems. It does this by measuring error rates,  $I_{11}$  and  $I_3$  signal levels, asymmetry, push-pull tracking, and radial noise. It will also generate permanent records of product performance for quality assurance. The system is designed for factory-floor operation by production personnel.

## ***Description***

This PC-based system plays discs off the production line, and measures several relevant signal parameters. These parameters can then be displayed or printed in graphic form showing performance over the whole disc. This information is saved to the hard disk for archival storage, and so that comparisons can be made between many discs of one production run. This comparison data is used to plot performance trends during the production run. The system produces various alarms to the operator to signal bad discs, or trends of degrading performance.

## **Data Acquisition**

The system will measure and plot the following parameters as a function of disc radius:

- a. Block error rate (BLER)
- b. Error rates for all error flags (E11, E21, E31, E12, E22, E32)
- c. Uncorrectable errors (E32 flag)
- d. Burst error rate
- e. HF signal level ( $I_{11}$ ), peak-to-peak
- f. HF signal asymmetry
- g.  $I_3$  signal level, peak-to-peak
- h. Radial noise, RMS
- i. Push-pull tracking level, peak-to-peak

Each of these signals can be displayed in graphic form as a function of disc radius or playing time.

Certain items are also listed on the printer, such as:

- a. E22 and E32 errors
- b. Burst errors
- c. Out-of-spec errors

Asymmetry range is -50% to +50%. Error rates can reach a maximum of 6,553 per second.

## **Automated QC records**

A work order number is entered for each production run and all data for that run is identified with this number. Each disc tested is uniquely identified for future reference. Besides the hardcopy plot of the signal parameters, the data is stored on the hard disk for archival storage. On demand, a trend report shows comparative performance for all discs since the beginning of a particular run. This report is also stored on disk. In addition, this data can be output as a Lotus 1-2-3 worksheet file, to simplify further analysis.

## **Alarms**

Visual and audible alarms are generated if any parameter goes outside specified limits. These programmed limits can be readily changed, but access is restricted by a secret code, to prevent unauthorized or accidental changing of parameter limits.

## ***Hardware Implementation***

### **Computer System**

- 233 MHz Pentium with keyboard, one floppy and a hard disk, 16M RAM, Windows 95.
- SVGA Color graphics adapter and monitor
- Printer with IBM compatible graphics

### **CD player**

The signals are read from the disc using a Clover systems player. This player has been designed to provide signals from the laser pickup and tracking servo and enable computer control of the player. The player utilizes the Philips CDM4 single-beam pickup, which is the industry standard for CD measurements.

### **Additional hardware**

A plug-in board is provided which captures and processes the signals from the CD player. The CD player connects to this board via a ribbon cable (DB-25 male - DB-25 male).

This board contains the signal decoding, error correction circuitry, and counters for the error flags. It also detects and counts burst errors, and decodes subcode channel Q to get timecode, TOC, UPC, and ISRC codes from the disc. It also provides analog signal processing and a 12-bit A/D converter for measuring  $I_{11}$ , push-pull tracking,  $I_3$ , radial noise, and asymmetry signals.

# INSTALLATION

**Your system has already been installed and configured. All you need to do is connect the monitor, printer, mouse, and QA-301 player to the computer.**

4. Connect the supplied cable from the DB-25 connector on the rear of the QA-301 board to the DB-25 connector on the rear panel of the CD player.
5. If you wish to monitor the sound, connect either the SPDIF or analog outputs of the player to your sound system.
6. Install the security key (dongle). The software will not be fully functional without this key installed. Plug the key supplied into the printer port of the computer, and then plug the printer cable into the key. If there is not enough room behind the computer to accommodate the key, you can install it at the end of a short extension cable.
7. Make a backup copy of the program disk.
10. Modify your AUTOEXEC.BAT file to include the line: GRAPHICS *myprinter*, where *myprinter* is the type of printer you have. For example: GRAPHICS DESKJET or GRAPHICS LASERJET. If using a dot matrix printer, use the command GRAPHICS GRAPHICS. For more information, consult your MS-DOS operating manual. You must re-boot after changing the file in order for the changes to take effect.

## ***In Case You Need to Re-install the system***

In case you ever need to re-install the system, here is what you must do:

1. Set I/O address switches on circuit board:

The CD Analyzer adapter board uses I/O addresses 220 hex through 23F hex. Be sure that there are no other adapters in your system which conflict with these addresses. Switch S1 sets the least significant bit of the I/O address (A5), and switch S5 sets the most significant bit (A9).

S1 = off

S2 = on

S3 = on

S4 = on

S5 = off

Off (open) = "1"

On (closed) = "0"

2. Set interrupt level jumper:

The CD analyzer uses two hardware interrupts: IRQ9 and IRQ3. IRQ9 is hardwired and cannot be changed by the user. The other interrupt is generated by the on board timer and can be selected via a jumper. For the version 3.0 and later software, a jumper must be installed on E1-E4. Be sure that there are no other boards in your system that also use these interrupts. IRQ3 is generally used for serial port COM2. If you have a COM2 serial port, make sure that it is NOT configured to IRQ3, or is disabled. QA-301 will operate properly in most computers with COM2 enabled as long as you don't try to use COM2 while running QA-301.

E1 = INSTALLED	IRQ3
E2 = OPEN	IRQ4
E3 = OPEN	IRQ5

3. Install the QA-301 board in any available slot of your computer.
4. Connect the supplied cable from the DB-25 connector on the rear of the QA-301 board to the DB-25 connector on the rear panel of the CD player.
5. If you wish to monitor the sound, connect either the SPDIF or analog outputs of the player to your sound system.
6. Install the security key (dongle). The software will not be fully functional without this key installed. Plug the key supplied into the printer port of the computer, and then plug the printer cable into the key. If there is not enough room behind the computer to accommodate the key, you can install it at the end of a short extension cable.
7. Make a backup copy of the program disk.
8. Create a directory for the QA-301 program and copy all of the distribution files to it. This directory must contain QA-301.EXE, and SETUP.DAT.
9. If you wish to use the secret access code feature, do not copy KEY.EXE to the working floppy or hard disk.
10. Modify your AUTOEXEC.BAT file to include the line: GRAPHICS *myprinter*, where *myprinter* is the type of printer you have. For example: GRAPHICS DESKJET or GRAPHICS LASERJET. If using a dot matrix printer, use the command GRAPHICS GRAPHICS. For more information, consult your MS-DOS operating manual. You must re-boot after changing the file in order for the changes to take effect.
11. Modify your CONFIG.SYS file to include the line: DEVICE=ANSI.SYS. This device driver must be loaded for the display to work correctly. You must re-boot after changing the file in order for the changes to take effect.

# OPERATION

The QA-301 software is a DOS-based program. You can run it in MS-DOS mode, or in a window under Windows 95. Operation is faster in MS-DOS mode, but if you are also using the Jitter Option, you can run both programs simultaneously under Windows.

MS-DOS: Set the current directory to the one that contains the QA-301 program, and start the program by typing "QA-301".

Windows: Double-click on the QA-301 icon on the desktop, or select QA-301 from the Start Menu.

Data is always stored on the drive and path designated as "data path" in the SETUP screen. Set the data path to the directory where you wish to save the data. The path name must always end in "\". The default is clover\data\.

Operation consists of capturing the signals from the CD player, monitoring for error alarms, and printing out the data for analysis. All menu commands are entered by pressing the capitalized letter (usually the first) of the command word. For instance, press "C" for Capture, or "F" for Files. Upper or lowercase is accepted.

## ***Data Capture***

All data except push-pull tracking is captured automatically from the CD player while it is playing. The push-pull tracking test is a separate procedure that is performed when first entering capture mode. Select "C" in the main menu for data Capture. Data is captured continuously for the entire playing time of the CD, or any portion you choose. With Quick-Scan on, samples are taken at regular intervals, allowing you to characterize an entire disc in just a few minutes.

## ***Monitoring***

Data can be monitored in real time as the disc is playing. The screen is color-coded to provide instant notification of error conditions: The normal condition is a BLUE background for the main menu screen.

A RED background in the main screen, means that some parameter in the data stream has gone out of range. This is only possible while in CAPTURE mode.

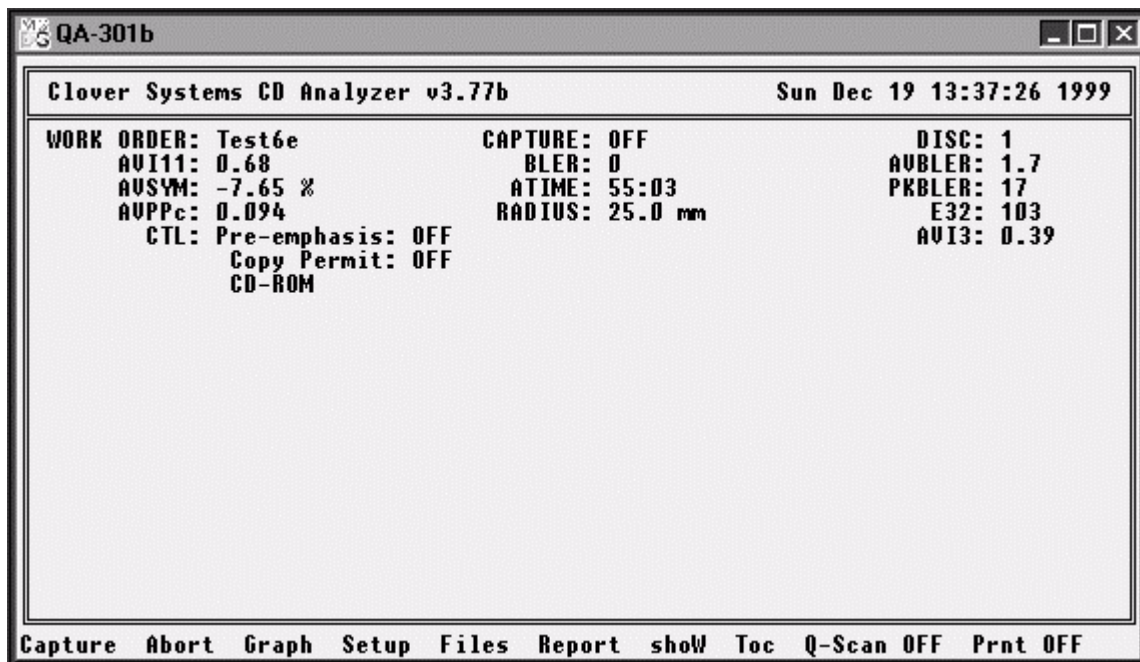
A GREEN background shows that the end of the disc has been reached, and CAPTURE mode has aborted automatically. The border of the screen remains RED if an alarm has occurred during the capture.

Eight data parameters are always displayed on the screen. The values are updated in real time during data capture. The parameters are:

1. AVI11 - average of all  $I_{11}$  readings across the disc
2. AVSYM - average of all ASYM readings across the disc
3. AVPPc - average push-pull (circular) value derived from TRACK test
4. BLER - current block error rate (for 1s period)
5. AVBLER - average of all BLER readings across the disc (ten sec. average)
6. PKBLER - peak (one sec.) block error rate across the disc
7. AVI3 - average  $I_3$  reading across the disc
8. E32 - total of all uncorrectable (E32) errors across the disc

In addition, the control bits embedded in the Q channel subcode are displayed:

Pre-emphasis ON/OFF  
Copy prohibit ON/OFF  
CD-Audio or CD-ROM  
4 Ch audio or 2 Ch audio



*Figure 1 -- Main Screen*

**Note:** The BLER and PKBLER displayed in the main screen is different from the BLER displayed in the graphs: The true BLock Error Rate (BLER) is defined as the average rate over any 10-second period. This is the value displayed in the graphs, and used to calculate the

average, peak, and standard deviation in the REPORT function. The BLER value displayed at the top of the main menu screen however, is a *one-second* average. In addition, the PKBLER displayed is the peak value of this *one-second* average BLER. As a result, the PKBLER and BLER values may be considerably higher than those shown in the graphs. The ten-second averages used for the graphs and Summary conform to the standards. The one-second averages displayed on the main screen provide increased sensitivity to small defects, so both measures are useful.

While capturing data, the current location on the disc is displayed, both in minutes and seconds of running time (ATIME), and in millimeters of radius. During the lead-in portion of the disc, the ATIME will display "LEAD-IN" since there is no timecode information in the lead-in.

Data may be displayed in graphic form while the test is running. The graphs will be updated in real time as the test proceeds. In this way, you can track the data as it is captured. Press "G" in the main menu to select graphics mode. An audible and visual alarm will instantly warn of any out of range data.

A summary of all results are displayed in the summary screen, which is displayed when you select "W" for shoW in the main menu. This summary shows minimum, maximum, and average values of all parameters over the whole disc. The summary can be printed by selecting Print in the summary menu.

If desired, all occurrences of out-of-range values can be logged on the printer as they occur (see PRINTER, pg. 22 ). Any instance where a measured parameter goes outside the limits set in the SETUP screen is listed on the printer, along with the timecode of the event, the name of the parameter that went out of range, and the actual measured value for that parameter. The timecode for these events has the form mm:ss:\*\* where mm is minutes, and ss is seconds. No frame number is printed since these measurements are made only every 10 seconds.

Any occurrence of an E22, E32 or burst error will be listed on the printer along with the timecode mm:ss:ff, type of error, and the number of errors that occurred in that frame. These errors are checked every subcode frame (75 times/second). All errors in the listing are numbered consecutively, starting at one.

When there are large dropouts, or uncorrectable errors, it is likely that the timecode will also contain errors. If a CRC error is encountered in the timecode, the last valid (error-free) timecode will be retained. A timecode reading of 00:00:00 indicates lead-in.

## **Data Analysis**

The QA-301 Compact Disc Analyzer provides graphic display of data so that a large amount of data can be easily analyzed and compared.

### 1. Printouts

Besides the error listing, all data that are displayed on the screen in the Graph mode can be printed on the printer. This is accomplished by dumping the entire screen to the printer using the Print command in the graphics menu. This provides a graphic record of disc performance, and the performance of various discs can be compared side by side. The graphs can also be used to locate physical defects on the discs.

### 2. Reports

Reports are a way of comparing performance of successive discs in a production run. This provides a record of measurements that can be related to production parameters, and therefore is a way to monitor the process. The average, peak and standard deviation of every parameter is calculated and stored for up to 100 discs. These values can then be displayed as graphs, which show the comparative performance of successive discs. This allows you to visually spot trends of degrading performance. Reports also calculate and display the average and peak values for the entire run of discs. Press "R" in the main menu to generate a report (see REPORT, pg. 16).

## **DESCRIPTION OF COMMANDS**

All commands are displayed in an on-screen menu at all times. Commands are executed by typing the letter associated with that command. In almost all cases, this is the first letter of the command. Sometimes two letters must be typed. In all cases, this letter(s) is capitalized in the command menu. The command processor will accept either upper or lowercase commands. Pressing the ESC key will always return you to the previous (or main) menu.

### • **CAPTURE DATA**

The operator is prompted for a work order number that will be associated with this production run. The work order number may consist of numbers or letters, up to seven characters. If a work order number has already been entered, and you do not wish to change it, type only ENTER, and the existing work order number will remain unchanged.

Next, the program prompts for the disc number. This is a number up to four digits that identifies this particular disc. The disc number may also contain letters. If no disc number is entered, the capture mode is aborted. The data will be saved in a file whose name consists of the work order number + disc number. Therefore, only DOS filename legal characters can be used (i.e. no space or period). If an illegal character is entered, an error message will be displayed.

After the player reads the Table of Contents, the program asks if this disc is a CD-Recordable. You can start the tracking test by pressing either Y or N. You can skip the tracking test by

pressing any key other than Y or N. The push-pull tracking signal is sampled as the disc is scanned from the beginning of track one to the lead-out. The push-pull signal is sampled at the same interval used by Quick-Scan. This value can be changed in the setup screen (see SETUP, pg 13).

After the push-pull tracking test is completed (or skipped), the program then prompts the operator for the starting location of the test. Press “L” if you wish to start the test at the beginning of the disc lead-in, or “C” if you wish to start the test at another location. If any key other than “L” or “C” is pressed, the capture command will abort. This allows you to bail out if you find you’ve made a mistake.

You may start the test at any point in the program by using the player controls to locate to the desired starting location, then press “C” to start the test (see PLAYER CONTROLS, pg 22). If no location is selected, the test will start at the beginning of the program.

The CAPTURE indicator will blink “ON” until the desired starting point is reached. At this point, the indicator will stop blinking, and turn green to show that data capture has begun. If there is no disc in the player, an error message will be displayed, and the command will be aborted.

The program now inputs data from the CD player until it is stopped (see ABORT, pg. 9). When the end of the disc is reached, CAPTURE is aborted automatically, the alarm will sound, and the screen will turn green. This tells you at a glance that the test has completed.

The data is continuously checked for “out-of-range” values. If any parameter goes out of range, an audible alarm will be sounded, and the screen will turn red. A blinking message is printed on the main screen, which tells which parameters have gone out of range. The blinking messages are displayed only on the main menu screen.

The audible alarm is sounded only on the first occurrence of an error. After that, the screen will be red, and the appropriate error warning message(s) will be displayed whenever in the main menu mode. Abort will clear the error messages, and return the main screen to blue.

If the printer is selected (see PRINTER, pg. 22), then each occurrence of an out-of-range value will be printed on the printer as it occurs.

This routine runs in the background, so all other functions can be run concurrently, except the LOAD command. That is, other commands can be executed while the capture command is running. This allows you to display the data as it is being acquired, print reports, etc. The LOAD command is disabled during CAPTURE, since it would write over the current data.

- **ABORT**

Aborts data capture mode so you can stop before you get to the end of the disc. Capture mode will abort automatically after 80 minutes, or upon reaching the end of the program. Capture can also be aborted manually by simply pressing stop on the CD player. The data is stored in memory arrays until the run is completed, then can be saved to disk. The operator is asked whether this data should be saved. If you respond with “Y” or “y” the data will be

saved. A filename is automatically generated that reflects the disc ID and work order number. The push-pull tracking test can also be aborted before the disc is scanned to the end. At that time, you can continue with the rest of the test.

- **GRAPH DATA**

The Graph command can display any of the 10 measured parameters as a graph with disc radius (or playing time) as the independent variable. Upon entering the display mode, a new menu is displayed, which allows you to select the parameter you want to display:

**BLer** - block error rate; Type BL.

**BUrst** - burst error rate; Type BU.

**Exy** - error rate for specific error flag; Type name of error flag, e.g. E11, E32.

**Hf** - HF (I11) level; Type H.

**Asym** - asymmetry amount in percent; Type A.

**Noise** - RMS radial tracking error in nanometers; Type N.

**I3** - I<sub>3</sub> signal; Type I.

**trK** - Push-pull tracking signal, Type K.

**Radius** - changes horizontal axis units to millimeters; Type R.

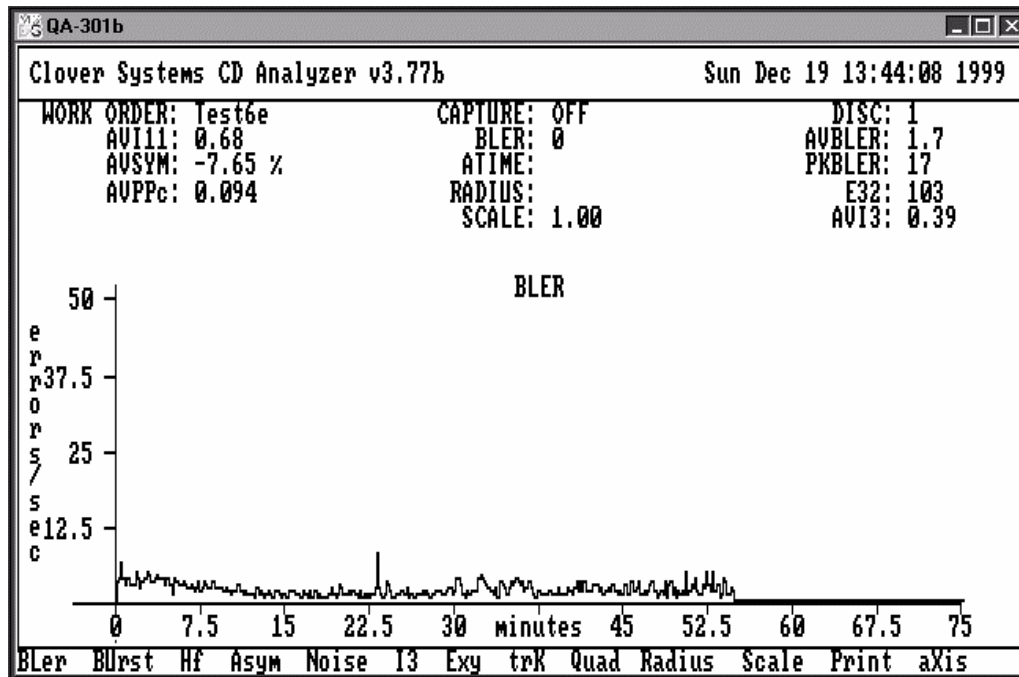
**Time** - changes horizontal axis units to minutes; Type T.

**Print** - dumps the screen display to the printer; Type P.

**Scale** - changes the vertical scale of the display; Type S.

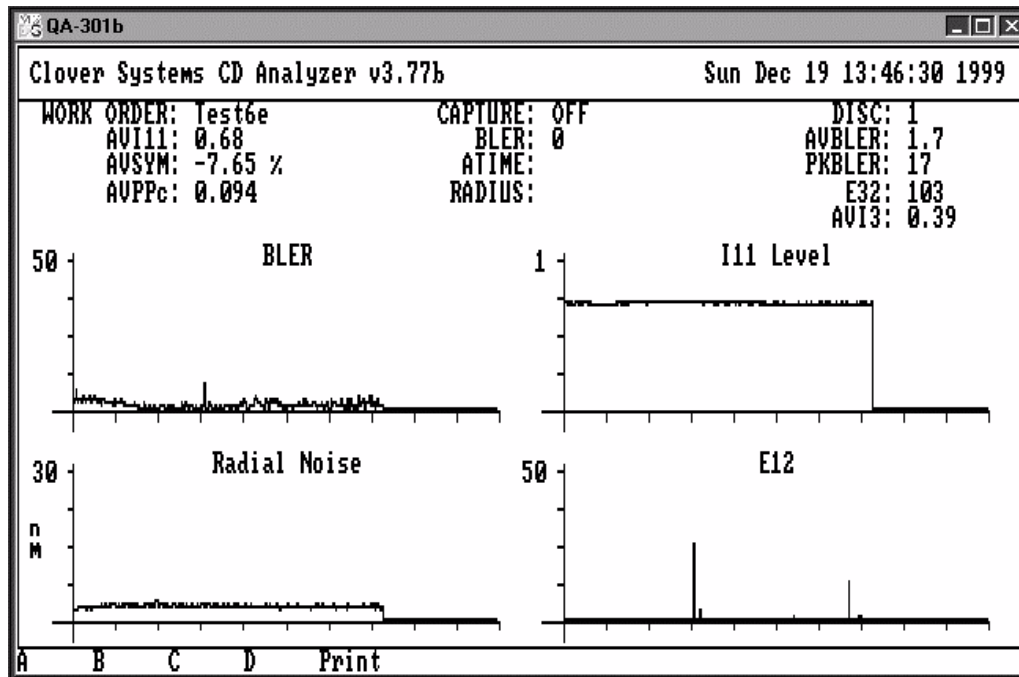
**aXis** - changes horizontal scale of the display; Type X.

**Quad** - displays four graphs at once; Type Q.



*Figure 2 -- Sample Graph Screen*

**QUAD DISPLAY** is similar to GRAPH mode, except you can display four parameters at once. Each graph can be individually selected by pressing a letter A-D. Each window is numbered, with #A being the upper left window. The upper right window is #B, lower left is #C, and lower right is #D. When you have selected a window to change, the menu changes to show the allowed selections. These selections are identical to those in the GRAPH menu. In capture mode all four displays will be updated in real time. Each graph will be scaled according to the scale factor set for that parameter. The upper end of the vertical axis is labeled with the full-scale value for that parameter.



*Figure 3 -- Sample Quad Graph*

The vertical axis of the display is controlled by the limits set in the SETUP screen as well as the SCALE factor displayed on the screen. With the SCALE factor set to 1.00, the height of the display is the SETUP LIMIT for that parameter. The range of the display can be easily changed by changing the SCALE factor. A SCALE factor of two makes the range of the vertical axis twice as large. Therefore, use a small scale factor to zoom in on low-level data, and use a large factor to display out-of-range data. The scale factor is stored separately for each parameter. Therefore, you can set the scale factors separately for each parameter, and whenever you switch between displays, the appropriate scale factor will be restored.

The horizontal axis units can be changed to read in either millimeters of radius, or minutes of playing time. The default mode is minutes. The “R” and “T” commands are used to switch between the two modes. When displaying disc radius in millimeters, the axis will be adjusted to reflect the currently set recording velocity. Changing the velocity (see SETUP, pg. 13) will cause a change in the millimeter scale, but will not affect the minutes scale.

The range of the horizontal axis can be changed with the aXis command. Upon typing “X” to initiate this command, the cursor will appear at the position of the full-scale value for the horizontal axis. You can now enter a new full-scale value for the horizontal axis. The value entered *must* be in minutes, even if the axis units are currently set to millimeters. The acceptable range of values is 10 minutes to 80 minutes. The default value is 75 minutes.

To correctly measure Radial Error (Noise), you **MUST** perform the push-pull tracking test at the beginning of CAPTURE. This is because the calibration of the radial error signal is dependent on the size of the push-pull tracking signal. If you skip the tracking test, the radial noise will not be measured.

## • **SETUP LIMITS**

Displays and allows setting of parameter values that will generate alarms. This provides a way to increase or decrease the sensitivity of the system. The operator must enter a secret code to gain access to the parameters that generate alarms. The recording velocity parameter does not generate any alarms, or alter the data in any way; it simply changes the display scale. Consequently, no access code is required to change the velocity parameter. On entry, 20 parameters are displayed:

- data path
- maximum block error rate
- maximum burst error rate
- minimum I<sub>3</sub> level
- minimum high frequency level (I<sub>11</sub>)
- burst error size in frames
- maximum rate for each error flag: E11, E21, E31, E12, E22, E32
- maximum asymmetry in percent
- minimum asymmetry in percent
- maximum radial error in nanometers
- maximum push-pull tracking level
- minimum push-pull tracking level
- recording velocity in meters/sec
- Quick-Scan interval
- Quick-Scan sample time

The data path specifies where the data files will be stored. Press “P” to enter the data path. Enter the drive and path name desired. If you use a subdirectory name, you **MUST** include a trailing backslash (\). For example: c:clover\data\.

You can also set the recording velocity. The recording velocity is used only to calculate the current radius while the disc is playing. If you do not set the correct value, the radius display may be slightly off. If you do not know the recording velocity of the disc, 1.4 m/s is a good bet for short programs, and 1.2 m/s for programs over 60 minutes.

To change the alarm limits, press “S”. The program then prompts for the Access Code. If an incorrect access code is entered, you will be returned to the main menu screen. The Access Code consists of four digits plus ENTER. The default code is 3489. The Access Code can be changed by using the KEY.EXE program. See “Changing the Access Code” on pg. 24.

**NOTE: The default access code is 3489**

If a valid Access Code is entered, the program sequences through the values, allowing you to change whichever ones you wish. If you don't want to change a value, simply press ENTER without a value, and the old value will be retained. Press ESC when you are finished changing values. After entering the last value or pressing ESC, you will be returned to the main menu.

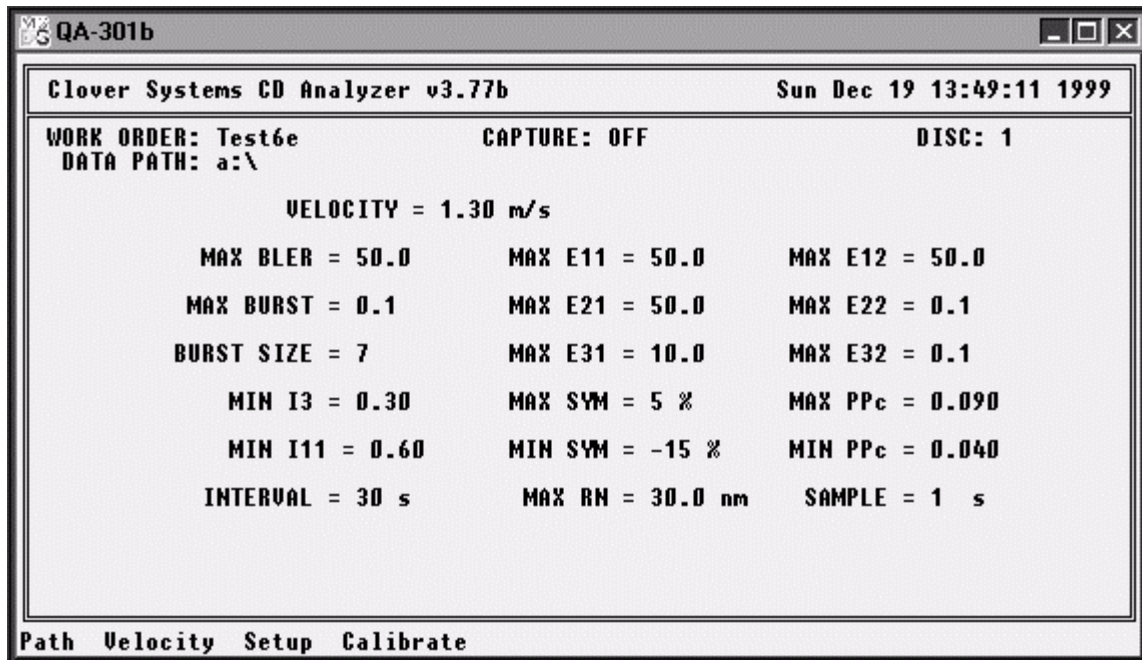
Whenever any of these values are changed, the new values are stored in a file called SETUP.DAT. This file is loaded each time the program is started up, so that the latest limit settings will be in effect until changed.

Burst error size is the number of consecutive frames with two or more bad symbols you want to define as an error burst. A burst error is counted whenever the number of consecutive bad frames is equal to or greater than this number. The Red Book defines a burst error as seven frames.

Burst error rate is the number of times per second that error bursts equal to or larger than burst size occur. Changing the burst error size makes this measurement more or less sensitive.

To measure Radial Noise, you must perform the push-pull tracking test at the beginning of CAPTURE. This is because the calibration of the radial error signal is dependent on the size of the push-pull tracking signal. If you skip the tracking test, the radial error measurement will not be made.

The Quick-Scan interval and sample length are entered in seconds. The interval can be any value from 10s to 4800s, but cannot be smaller than the sample length. The sample length can be 1-10s, 20s, 30s, etc. up to the interval length.



*Figure 4 -- Setup Screen*

- **FILES**

Selecting Files will cause a new menu to be displayed on the menu line. These functions are all used for dealing with disk files:

- **DIR**

Displays the directory of the current data path. There are two types of data files generated: Data files for individual discs, and Report files. Whenever the data from a disc analysis is saved (after CAPTURE), a file is created which has a unique name made up of the work order number and the disc number. In this way, each disc has its own uniquely named data file. In addition, the calculated data from that disc is appended to the report file for that work order. For each work order, a report file is created which has the work order number as its name, and the file extension RPT.

Example:

disc data file - wwwwwwwd.ddd

report file - wwwwww.rpt

where wwwwww is the 7-char work order number, and dddd is the 4-digit disc number.

- **SAVE**

This command allows you to save the current data any time you wish. Two files are created when you save the data. One is a REPORT file (see REPORT) which is appended each time you save data for a particular work order. The other file is specific to each disc, and contains all data for that disc.

- **LOAD FILE**

This command allows you to load in data from previous tests that has been stored. Prompts for Work Order and Disc Number. The complete data for that disc is loaded into memory, and can be displayed and/or printed. This command will not execute if the program is in CAPTURE mode. This is to prevent writing over the current data.

- **ERASE**

Allows you to delete files from your data disk. Prompts for the name of the file to be deleted. You may also use wildcards, & pathnames.

- **FORMAT**

Allows you to format new floppy disks. New disks must always be formatted before they can be used to store data. Also allows you to assign a volume label to a disk. The format program will instruct you to put a disk in drive B, and press carriage return. When the format is complete, the program will ask you for a “volume label.” This is an 11-character name that you can assign to this disk. This is useful in keeping track of your data disks. Each data disk can be assigned a unique label in keeping with your library scheme. Only 11 characters can be entered, and certain characters such as hyphen and period are not allowed. Numbers, letters, and underline are OK.

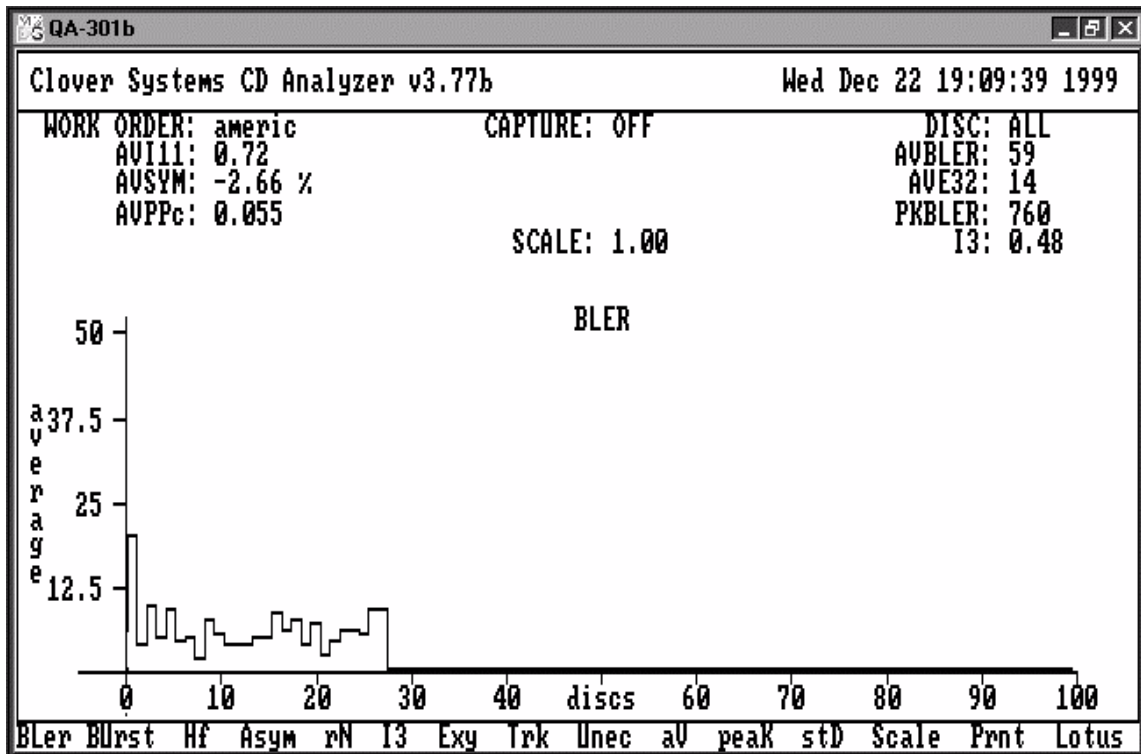
- **REPORT**

Generates analysis reports for a production run. The operator is prompted for the Work Order Number. The following data is displayed, along with a new menu:

- Average block error rate for entire run
- Peak block error rate (ten-second) for entire run
- Average of total number of uncorrected errors for entire run
- Average asymmetry for entire run
- Average HF ( $I_{11}$ ) level for entire run
- Average PPc tracking value for entire run

The new menu provides for displaying and/or printing 22 parameters as a function of disc number. Notice that the parameters described above are averages over the entire run, whereas the graph shows the values for each disc. In this way, a trend line is created, showing the performance of successive identical discs.

The command menu for Report works the same as for Graph. Also, the Peak command (press "K"), will cause the display to be converted to peak values, and the aVerage command (press "V") will cause average values to be displayed. Pressing "D" will display the STANDARD DEVIATION of the selected parameter. This shows the amount of variation of the parameter over the disc.



*Figure 5 -- Report Screen*

The LOTUS command will convert the report data to a Lotus 1-2-3 worksheet file. This file can then be loaded into a spreadsheet (Lotus or Excel) for further analysis. The spreadsheet file contains one row for each disc of the work order. The columns are arranged in the following manner:

<u>column #</u>	<u>description</u>
1	work order number
2	disc number
3	average BLER
4	peak BLER
5	average burst error rate
6	average HF ( $I_{11}$ )
7	average ASYM in percent
8	total uncorrectable errors
9	Push-Pull TRK value (circular)
10	average $I_3$

- **SHOW RESULTS**

Displays a summary of all test results, including minimum, maximum, and average values for each parameter over the whole disc. For minimum and maximum values, the ATIME where that value occurred is also displayed. This display is updated each ten seconds when capturing data. This screen can be sent to the printer by pressing Print.

	Minimum	at ATIME	Maximum	at ATIME	Average
BLER:	13.6	10:27	23.9	10:47	20.0
E11:	13.4	10:27	23.5	11:27	19.1
E21:	0.0	10:27	2.1	10:57	0.3
E31:	0.0	10:17	3.0	10:47	0.3
E12:	0.0	10:17	10.1	10:47	1.1
E22:	0.0	10:17	0.0	00:00	0.0
E32:	0.0	10:17	0.0	00:00	0.0
BRST:	0.0	10:17	0.0	00:00	0.0
I11:	0.64	10:37	0.65	11:27	0.65
I3:	0.42	10:27	0.43	11:27	0.43
ASYM:	-4.7	11:57	-4.2	10:27	-4.5
RN:	2.9	11:27	3.7	10:27	3.2
PPc:	0.055	59:31	0.062	16:30	0.059
PPp:	0.061	59:31	0.065	16:30	0.063
TOT E22:	0				
TOT E32:	0				

Over-range Print ESC

*Figure 6 -- Summary Screen*

- **OVER-RANGE ERRORS**

The over-range / burst error list described above can also be viewed on the screen, instead of or in addition to listing to the printer. Press “O” in the Summary screen menu to show the error list. Use the Home, End, PgUp, and PgDn keys on the keypad to scroll through the list.

The error list can hold up to 1024 over-range, E22, E32, or burst errors. If the number of errors exceeds this value, the beginning of the list will be written over. The list is saved to disk with the rest of the data, and is restored when you load data using the Load command.

No.	ATIME	TYPE	VALUE
1	28:28:18	E22	1
2	35:50:37	BURST	1
3	35:51:10	BURST	1
4	40:45:11	BURST	1
5	40:45:28	E22	1
6	40:45:45	E22	1
7	40:45:45	BURST	2
8	40:45:45	E22	1
9	40:45:59	BURST	1
10	40:45:62	BURST	1
11	40:46:03	E22	1
12	40:46:03	BURST	2
13	40:46:03	E22	5
14	40:46:05	BURST	1
15	40:46:20	BURST	1
16	40:46:21	E22	1
17	40:46:37	E22	3
18	40:46:37	BURST	1

Home PgUp PgDn End Print ESC

*Figure 7 -- Over-range Screen*

- **TABLE OF CONTENTS**

The table of contents of the disc is read and stored at the beginning of the test. The table of contents can then be displayed by pressing “T” in the main menu. If there are more tracks than will fit on one screen, you can scroll through the list using the Home, End, PgUp, and PgDn keys on the keypad. In addition, you can dump the table of contents to the printer by pressing “P.” This print feature is defeated during CAPTURE if PRINTER is ON, so that it will not interfere with the error listing (see PRINTER, pg. 22).

In addition to the start times of all tracks, the TOC screen displays the UPC/EAN (bar code) of the disc (if used), and the ISRC codes of all music tracks (if used). The ISRC codes identify the copyright holder of each music track. Since this information is encoded in the subcode of each individual track, it is only read when the track is played. Therefore, the ISRC codes appear in the TOC listing only after that track has been played. If you wish to read all ISRC codes without testing the whole disc, you can test just the first few seconds of each

track. UPC/EAN code is encoded in the lead-in, and is read along with the rest of the table of contents at the start of the test.

The screenshot shows a window titled 'QA-301b' with a 'Table of Contents' header. Below the header is a table with the following columns: Trk No., ATIME, ISRC, CopyPermit, Type, and Pre-emphasis. The table lists 13 tracks, each with a 2-CH AUDIO type and OFF pre-emphasis. A 'Lead-out' track is listed at the end with a time of 53:53:34. At the bottom of the window, there are navigation options: Home, PgUp, PgDn, End, and Print.

Trk No.	ATIME	ISRC	CopyPermit	Type	Pre-emphasis
1	00:02:00	USMC19546292	OFF	2-CH AUDIO	OFF
2	03:42:65	USMC19546719	OFF	2-CH AUDIO	OFF
3	07:47:65	USMC19546720	OFF	2-CH AUDIO	OFF
4	11:40:37	USMC19546289	OFF	2-CH AUDIO	OFF
5	16:12:37	USMC19546716	OFF	2-CH AUDIO	OFF
6	20:05:45	USMC19546717	OFF	2-CH AUDIO	OFF
7	24:25:22	USMC19546287	OFF	2-CH AUDIO	OFF
8	28:25:37	USMC19546288	OFF	2-CH AUDIO	OFF
9	32:10:10	USMC19546721	OFF	2-CH AUDIO	OFF
10	35:49:50	USMC19546722	OFF	2-CH AUDIO	OFF
11	40:44:20	USMC19546722	OFF	2-CH AUDIO	OFF
12	44:48:50	USMC19546747	OFF	2-CH AUDIO	OFF
13	48:58:52	USMC19544923	OFF	2-CH AUDIO	OFF
Lead-out:	53:53:34				

Figure 8 -- Table of Contents Screen

• **QUICK-SCAN**

When capturing data, you may start at any point on the disc, and also scan ahead while capturing data. In this way, you can test selected portions of the disc. QUICK-SCAN allows this process to be automated. When QUICK-SCAN is ON, samples are taken at user-determined intervals. In this way, you can test an entire disc in as little as a few minutes.

Both the length of the sample and the interval between samples can be set in the SETUP screen. The sample length can be set from one to 10 seconds in one second steps, and then up to the interval length in 10 seconds steps.

The lead-in portion of the disc cannot be tested with QUICK-SCAN.

In general, longer samples will give better correlation with the normal test mode for the various errors, but for the analog values such as HF, I<sub>3</sub>, and ASYM, excellent correlation can be achieved with samples as short as 1 second, since these signals do not change rapidly. Obviously, when sampling there is a possibility of missing some significant event, such as an E32 error. However, if done properly, almost no information is lost. This is because in order to cause an E32 error for instance, a defect must in principle be greater than two millimeters in length. If we assume that the defect is circular, which is usually the case, then if we sample more often than every two millimeters of radius, we will not miss any serious defects. In real life, smaller defects can cause uncorrectable errors. But if you sample every half millimeter

for instance, you will not miss any major defects. In cases where you know what the expected result is, you can sample at larger intervals. Conversely, if you need a high degree of confidence on an unknown disc, it may be best not to use Quick-Scan. Pressing “Q” in the main menu will toggle the Quick-Scan mode on and off.

## • **PRINTER**

The PRINTER command turns the error listing feature on and off. When the listing feature is turned on (command menu shows “Printer On”), then whenever an out-of-range value, burst error, E22 or E32 error is encountered during CAPTURE, the error will be logged on the printer. For each error, the absolute timecode, the type of error, and the parameter value are printed.

This feature can be turned on and off at will, even during data capture. Pressing “P” will change the mode, and the current mode is always displayed on the menu line.

If error logging is turned on, and you are in CAPTURE mode, you will not be able to use the PRINT command in GRAPH, QUAD, or REPORT to print graphs, nor will you be able to print the table of contents. However, you can temporarily turn error logging off, print a graph, then turn it back on. When not in CAPTURE mode, the PRINTER mode has no effect on the printing of graphs. While error logging is OFF, errors are buffered in memory, then dumped to the printer when PRINTER ON is selected. The error buffer is cleared when the CAPTURE command is initiated.

## • **PLAYER CONTROLS**

The 10 function keys on the keyboard (F1-F10) are used to control the player. These keys do not function when you are in the SETUP or SUMMARY screens.

F1 - PLAY	Starts the player playing. If already playing, restarts at the beginning of the current track.
F2 - STOP	Stops the player if it was playing.
F3 - PAUSE	Pauses the player during play.
F4 - REM/LAP	Selects between ATIME, remaining ATIME, PTIME, and remaining PTIME.
F5 - < TRACK	Move to the previous track.
F6 - > TRACK	Move to the next track.
F7 - << SCAN	Scan backward. Hold down until you reach desired location.
F8 - >> SCAN	Scan forward. Hold down until you reach desired location.

The Clover Systems CD player works just like an ordinary CD player, with a few exceptions: You can start playing from the start of lead-in, and there is a special open-loop tracking mode used for measuring push-pull tracking.

After inserting a disc and closing the drawer, the player reads the table of contents and displays the number of tracks on the disc. During normal operation, the player is controlled by the computer. However, if you wish to control the player manually, the following commands can be entered from the player front panel, or the keyboard function keys.

### **PLAY**

Press the PLAY button to start playing at track 1. If you want to start playing at some other track, press the < or > buttons to select the track number you want. Pressing PLAY will now cause it to start playing at the selected track.

### **STOP**

The STOP button will stop the player if it is playing. It also exits Open Loop Tracking Mode.

### **PAUSE**

Pressing the PAUSE button while playing will suspend play mode. Pressing it again will resume playing at the same location. The player will not PAUSE when playing the lead-in.

### **> ( NEXT TRACK )**

This causes the player to move ahead to the next track. If you are already at the last track, it will wrap around to the first track.

### **< ( PREVIOUS TRACK )**

This causes the player to move back to the beginning of the previous track. If you are at the first track, it will wrap around to the last track.

### **TIME Formats**

There are two types of timecode recorded on the disc: Absolute Time and Program Time. Absolute Time starts at 00:00:00 (minutes, seconds, and frames) and runs continuously for the total time of the disc. Program Time starts at 00:00:00 at the start of each track, and shows how long that track has been playing.

The TIME button allows you to change the player display from Program Time to Remaining Program Time, to Remaining ATIME.

Remaining Absolute Time is the time remaining until the end of the program area of the disc. This is useful if you want to know how long it will be before the test finishes.

Program Time starts at 00:00:00 at the start of each track, and shows how long that track has been playing. Note that even for track 1, ATIME (which is displayed by the QA-301 software) and Program Time are not the same. ATIME starts at the beginning of the 2 second

pause before track 1, whereas PROG starts after the two second pause before track 1. Therefore, ATIME will always be larger than PROG by at least two seconds.

Remaining Program Time is the time remaining until the end of the current track.

## **TERMINATING THE PROGRAM**

Typing Ctrl-C stops the program and returns you to the operating system. Aborts CAPTURE and allows you to save data if you were in that mode.

## **CHANGING THE ACCESS CODE**

The secret access code that allows you to change the alarm limits can be changed by using the program called "KEY.EXE" provided on the distribution disk. This program should not be included on the work disk if you wish to use this security feature.

The access code is contained in the file SETUP.DAT. The KEY program looks in the current directory for SETUP.DAT so be sure you are in the correct directory before running KEY.

The program will display the current access code on that disk, and allow you to change it. This program is also useful if you forget the access code.

## **INTERPRETING THE RESULTS**

### ***Measuring Error Rates***

Any serious disc defects will cause an increase in the error rates. Therefore, error rates give a good indication of disc quality. High error rates are generally caused by physical defects or poor pit geometry.

Although in some sense any disc that plays without uncorrectable errors is "perfect," there are other considerations. For one thing, we may wish to know how close is it to getting uncorrectable errors. Obviously, a disc with very low error rates has more tolerance for dirt, scratches, and the differences of players before it will produce an uncorrectable error. Other discs, although they may not produce uncorrectable errors, may be on the verge of doing so. In addition, older first generation players may produce many uncorrectable errors on such a disc because they use a less effective error correction algorithm than newer players.

A CD could not work without a highly effective error detection and correction scheme. Because the pits on the CD are so small, it is impossible to read the disc without errors. Keep in mind that the width of the pits is smaller than the wavelength of light used to read them! Therefore, it is the error detection and correction codes that really make the CD feasible. The error detection and correction code used on CDs is known as Cross Interleave Reed-Solomon Code (CIRC).

This scheme uses two principles to achieve a remarkable ability to detect and correct errors. The first is redundancy. This means that extra data is added. For instance, if all data were recorded twice, you would have twice as good a chance of recovering the correct data. The CIRC has a redundancy of about 25%. But the extra data is cleverly used to record information *about* the original data which provides the ability to deduce what the missing information must have been.

The other principle used is interleaving. This means that the data is distributed over a relatively large physical area. If the data were recorded sequentially, a small defect could easily wipe out an entire word. With CIRC, the bits are interleaved before recording, and de-interleaved on playback. What happens is that the bits of individual words are mixed up and distributed. With CIRC, one data frame is distributed over the space of 109 frames. Now, to completely obliterate a single frame, you have to wipe out 109 frames. Typical defects only obliterate small pieces of many frames instead of a large piece of one frame. Using this scheme, there is almost always enough left of each sample to reconstruct it. To completely wipe out a data word would require a hole in the disc of about 2 mm diameter.

The CIRC error correction used in CD players uses two stages called C1 and C2, with de-interleaving of the data between the stages. The error correction chip in this unit uses the "Superstrategy" algorithm that can correct two bad symbols per block in the first stage, and two bad symbols per block in the second stage.

Therefore, the error type E11 means one bad symbol (byte) was corrected in the C1 stage. E21 means two bad symbols were corrected in the C1 stage. E31 means that there were three or more bad symbols at the C1 stage. This block is uncorrectable at the C1 stage, and is passed to the C2 stage. Because of the de-interleaving of the data between the stages, those three (or more) bad symbols are now in separate blocks, and so can be corrected by the C2 stage.

E12 means one bad symbol was corrected in the C2 stage, and E22 means two bad symbols were corrected in the C2 stage. E32 means that there were three or more bad symbols in one block at the C2 stage, and therefore this error is not correctable.

BLER (Block Error Rate) is defined as the number of data blocks per second that have any bad symbols at the input of the C1 decoder. This is the most general measurement of the quality of a disc. The "Red Book" specification (IEC 908) calls for a maximum BLER of 220 per second averaged over ten seconds. Discs with higher BLER are likely to produce uncorrectable errors. Nowadays, the best discs have average BLER below 10. A low BLER shows that the system as a whole is performing well, and the pit geometry is good.

However, BLER only tells you how many errors were generated per second, it doesn't tell you anything about the severity of those errors. Therefore, it is important to look at all the different types of errors generated. Just because a disc has a low BLER, doesn't mean the disc is good. For instance, it is quite possible for a disc to have a low BLER, but have many uncorrectable errors due to physical defects. The smaller errors that are correctable in the C1 decoder are considered random errors. Larger errors like E22 and E32 are considered burst errors and are generally caused by physical defects.

As you might imagine, the sequence E11, E21, E31, E12, E22, E32 represents errors of increasing severity.

In order to work properly, the pits on the disc must have a certain size and shape. There are specifications for pit length, depth, and width, but you would need an electron microscope to measure them! Pit geometry can be measured indirectly by looking at signals like I<sub>11</sub>, I<sub>3</sub>, push-pull, and asymmetry.

Disc performance can only be measured by playing the disc. Unfortunately, when you measure discs by playing them back, you are measuring the performance of the player as well as the disc! As a result, it is quite possible for discs that measure good to have problems playing on certain players. Similarly, discs which measure badly may work fine on other players, and even measure differently on other analyzers. Different players are variously sensitive to different parameters such as asymmetry and tracking. Single-beam players such as this one, tend to be less forgiving in terms of the tracking signal. Therefore, it sometimes happens that a disc that will not play on a single-beam player might play fine on a three-beam player. A three-beam player, on the other hand is more sensitive to variations in track pitch or vibration, for instance.

Please remember that an error on a disc is not a physical thing. It is a manifestation of how well the total system (disc + player) is working. The disc itself does not have an error rate; playing the disc produces errors.

Ideally, what you want is a disc that will play back on ALL players with a low error rate. Unfortunately, there are no standards for players, only for the discs. Therefore, each type of player will give different results. The most widely accepted setup for testing CDs is a Philips single-beam pickup. That is why we use this type of pickup. This setup also tends to be rather sensitive in that discs outside the Red Book specifications will have trouble playing. This means that you may encounter discs that will play on other players, but have trouble on your QA-301.

Our players are designed to play "Red Book" specification discs. If a disc is found that won't play or gives poor results, yet plays on another player OK, there is certainly something wrong with that disc. We feel it is better to test under worst-case conditions than to be fooled into thinking that a bad disc is good.

### ***Measuring Pit Geometry***

Measuring error rates is useful because any serious problems will be reflected in higher error rates. But when it becomes necessary to establish the cause of high error rates, or determine if a disc is likely to play in all players, you must look at the geometry of the pits. Deviations from the ideal size and shape of the pits is one cause of playback problems (errors). In order to work properly, the pits on the disc must have a certain size and shape. There are specifications for pit length, depth, and width, but you would need an electron microscope to measure them! Pit geometry can be measured indirectly by looking at signals like I<sub>11</sub>, I<sub>3</sub>, push-pull, and asymmetry.

Pit depth is one of the most important element of pit geometry, since this is what causes interference in the laser beam that generates the playback signal. Pit depth is measured by looking at  $I_{11}$  and push-pull. As long as both  $I_{11}$  and push-pull are within their Red Book limits, there should be no problems, but it turns out that there are optimum values for each. Making a disc with high  $I_{11}$  causes it to have low push-pull, and vice-versa. Best performance is obtained when  $I_{11}$  is around 0.67 and push-pull is around 0.067.

The QA-301 automatically measures HF ( $I_{11}$ ),  $I_3$ , push-pull, and asymmetry. The HF output jack on the rear panel provides a means of monitoring the EFM "eye pattern" coming off the pickup, and also allows you to make certain additional measurements. This output signal is low impedance, approximately two volts peak-to-peak. It is DC coupled so that you can measure  $I_{11}$  and  $I_3$  relative to  $I_{top}$ , plus reflectivity.

## **MAINTENANCE AND SERVICE**

If you need to replace the fuses for any reason, use a 1/2 A fuse. There are also two 1 A fuses located on the AC input circuit board in the left rear corner of the unit. that can be accessed by removing the top cover.

If you need repairs, send the system to us. Call us for help in diagnosing the problem, and to get a return authorization.

Please save the original shipping carton and packing materials in case you need to ship it for any reason. If you are unable to save the original shipping materials, you *must* wrap the player in at least 3" of bubble-pak before shipping.

## ***CALIBRATING THE SYSTEM***

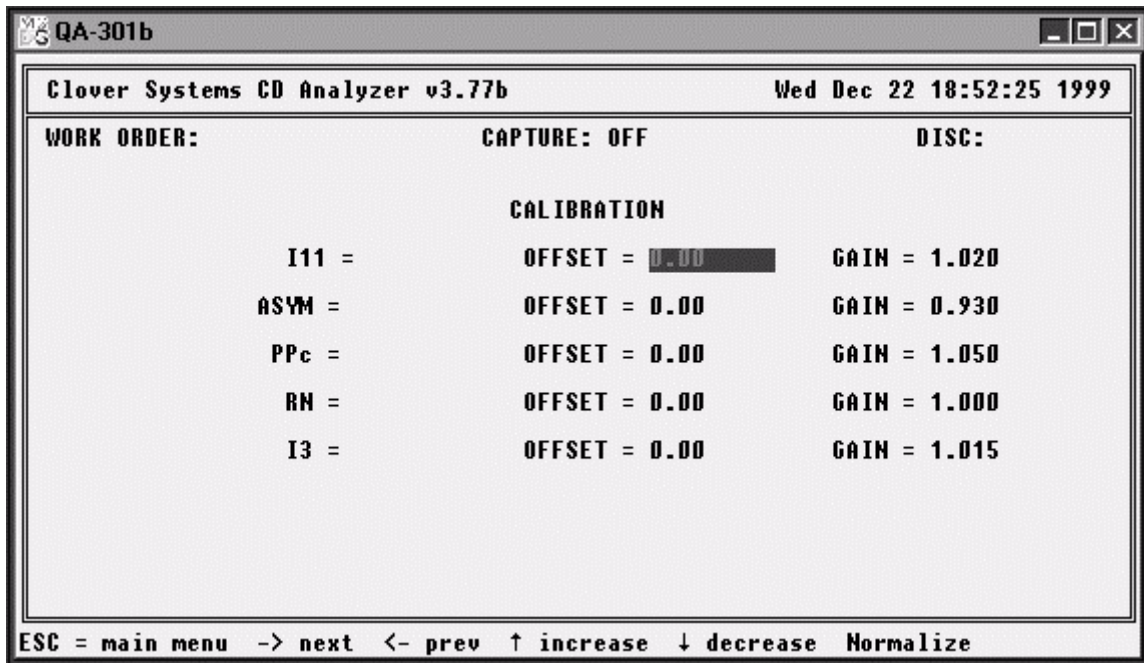
Some signals measured by the system are analog values that must be calibrated. The error rate measurements require no calibration. The CALIBRATION screen is accessed from within the SETUP screen. This screen will continuously display the values of HF,  $I_3$ , PPC, ASYM, and RN as measured by the system. The CALIBRATION screen allows you to set the DC offset and gain of each of these signals without having to open the computer or adjust any trimpots.

### **PROCEDURE:**

1. First make sure that the values you measure from your calibration disc (Philips 5B or Clover MPC) are reasonably close. If You have changed player, processor board or computer, you should adjust the trimpots on the interface and processor boards to get close to the correct measured values without using the software calibration. The system is calibrated when sent from the factory, so this procedure is only necessary if you change the player, processor board, or computer.

If you need to adjust the trimpots, you will need to remove the PC case and player top cover to gain access to the trimpots on the processor board inside the PC, and the

interface board in the player. The locations of the trimpots are shown in the drawings at the end of this manual.



*Figure 9 -- Calibration Screen*

## 2. NORMALIZATION

The values displayed in the program are “normalized” values. They are converted to the appropriate units to match Red Book Specifications. For calibration purposes, it is also useful to display the raw signal in volts (un-normalized). Pressing “N” in the CALIBRATION screen will toggle the display between normalized units and volts. You can tell when normalization is off, because “v” (for volts) will be displayed after each value.

## 3. CHANGING THE VALUES

You can navigate between fields using the left and right arrow keys. To change a value, you can type in a value, or use the up & down keys to increment / decrement the value in small steps. Press ENTER after typing in a value.

### 3. HF(I<sub>11</sub>), RN & PPc OFFSET controls

With the CD player connected and turned on, but stopped, set the HF, PPc and RN offsets so that a reading of 0.0 volts is obtained on the calibration screen (normalization off).

### I<sub>3</sub> OFFSET

Set the I<sub>3</sub> offset to 0.03 volts (normalization OFF) with the player stopped.

#### 4. HF ( $I_{11}$ ) and $I_3$ GAIN

Play a calibration disc. You may use the calibration disc provided, or use one calibrated to your own standards. Play the disc and with normalization ON, set the HF and  $I_3$  gain to obtain the desired reading.

#### 5. PPc GAIN

To adjust the Push-Pull gain, start the program in CAPTURE mode and start the push-pull test (see CAPTURE, pg. 8). Now go to the CALIBRATION screen, and adjust PPc gain (with normalization ON) to match the correct value. Use the values for circularly polarized light if using Philips disc 5B.

Some of the values tend to jump around while the disc is playing. It is therefore best to fine-tune the calibration by testing the disc in CAPTURE mode, and observing the results. You can switch back and forth between the CALIBRATION screen and the graphs, to see the effect of your adjustments.

#### 6. ASYMMETRY OFFSET & GAIN

The asymmetry offset must be set while playing a disc. If there is no input signal, the system tries to measure the asymmetry of random noise. Using the Clover Multi-Point Calibration Disc provided with the QA-301, set the asymmetry offset by playing track 10. Track 10 is closest to 0% asymmetry. Set the offset control so that the correct reading is obtained.

The asymmetry gain is set by playing track six of the Clover Multi-Point Calibration Disc. Track six has the highest asymmetry. Play track six of the calibration disc, and set the ASYM gain for the correct reading.

#### 7. RADIAL NOISE GAIN

The PPc signal must be calibrated before this adjustment can be made. It will also be affected any time you change the PPc calibration. You must then run the push-pull test in CAPTURE mode to obtain the push-pull value for the disc. Now go back to the CALIBRATE screen and set the gain to obtain the correct value while the test disc is playing.



## APPENDIX A - CONNECTOR DIAGRAM

### *Version 3 Connector Pinout*

<u>DB-25 Pin No.</u>	<u>Designation</u>	<u>Player Pin Number</u>
1	HF	1
2	MUSB*	2
3	RT	3
4	RN	4
5	I3	5
6	MPURES	6
7	REM	7
8	SERVICE	8
9	S8	
10	S9	
11	S10	
12	S11	
13	S12	
14	A/D-6	9
15	HFEQB	10
16	A/D-8	11
17	GND	12
18	RM	13
19	DAC	14
20	NEXT	15
21	S13	
22	DATA	
23	APTR	
24	BCLK	
25	APTL	



## APPENDIX B - OTHER ADJUSTMENTS

### 1. RN Notch Filter

**Ordinarily, the notch filter should never need to be adjusted after it leaves the factory.**

To adjust the notch filter, connect an oscilloscope or spectrum analyzer to TP1 on the player interface board in the player. While playing a disc, adjust each of the trimpots NOTCH1, NOTCH2, and NOTCH3 for the minimum reading of the (aprox.) 600 Hz component.

If you are using an oscilloscope, adjust the pots for the minimum p-p signal. When properly adjusted, the signal should look basically random. At this point, you can get a more sensitive measurement by connecting the 'scope (or a voltmeter) to TP4, and adjusting the pots for minimum DC voltage.

\*\*\*\*\* **WARNING** \*\*\*\*\*

Always turn the power to the player OFF before connecting any test probes to the connector pins. If you accidentally short the test probe to an adjacent pin, it could damage the circuitry!

These three pots control a twin-T notch filter that must be set to the frequency of the RT “wobble” which is approximately 600 Hz. Since there is interaction between the pots, you may have to adjust each one several times. Adjust NOTCH1, then NOTCH2, and then NOTCH3; then NOTCH1 again, etc. As you approach the correct setting, the sensitivity of the pots will increase. If the pots get turned way out of adjustment, it is possible for the filter to oscillate. You can easily detect this condition by looking at TP1 with an oscilloscope. Similarly, if the adjustment is very far off, you may not notice any change while turning the pots. If this happens, start by setting the pots to the center of their range by counting turns.

### 2. Calibrating RN without a disc

Connect an oscillator to pin 4 of J1 on the player interface board. The player should be stopped. Set the oscillator frequency to 1 kHz, and adjust the oscillator level so that you get a reading of about 0.4v for PPc on the calibration screen (normalization off). Then adjust the RN gain trimpot on the player interface board so that the RN reading on the screen is exactly 10 times the PPc reading. Since the maximum input voltage is 5.0 volts, you must keep the PPc signal below 0.5v. Lower the level of the oscillator output and verify that the RN reading tracks.

### 3. I<sub>3</sub> TUNING

Similarly, the I<sub>3</sub> measuring circuit must be tuned to 720kHz. **This adjustment should never change, so it is ordinarily not necessary to adjust it.** Connect the oscillator to TP5. Connect the oscilloscope to TP2 and set the oscillator to exactly 720kHz using a frequency counter, and one volt peak-peak. Adjust inductor L1 for a

maximum reading on the oscilloscope. Alternatively, you can connect a spectrum analyzer to TP2 and adjust L1 for a maximum peak at 720kHz while playing a disc.

#### 4. CLOCK PLL

The clock recovery phase-lock-loop is adjusted using T1 on the processor board.

**Once set, there is ordinarily no reason to change it.**

To adjust T1, attach a voltmeter or oscilloscope to pin 18 of U18. With the player playing, adjust T1 so that the voltage on pin 18 of U18 is \_\_\_\_\_v +/- 0.2v.

NOTE: When adjusting the trimpots on the processor and interface boards, there may be some interaction between the gain and offset adjustments, so if a large change is made in one adjustment, you should check to see if the other adjustment needs to be fine-tuned. It is also possible to test the linearity by checking the settings at different signal levels. In general, a more accurate setting can be obtained with a large signal. Some of the measurements have long time constants, so you will need to make the adjustments slowly.

## APPENDIX C - CALIBRATION DISCS

### Clover Systems Multi-point Calibration Disc

<i>Track No.</i>	$I_{11}$	<i>ASYM</i>
6	0.70	-14.5%
10	0.68	-1.5%
14	0.59	+7.1%
16	0.69	-6.9%

### Philips SBC 444A

<i>Track No.</i>	$I_{11}$	$I_3$	<i>PPC</i>	<i>ASYM</i>
6	0.67	0.46	0.053	-6.9%

### Clover Systems Disc 6D

<i>Track No.</i>	$I_{11}$	$I_3$	<i>PPC</i>	<i>ASYM</i>	<i>BLER</i>	<i>REF</i>
6	0.76	0.60	0.041	-2.3%	11.5	73.8%

### Clover Systems Disc 6E

<i>Track No.</i>	$I_{11}$	$I_3$	<i>PPC</i>	<i>ASYM</i>	<i>BLER</i>	<i>REF</i>
1	0.73	0.41	0.084	-6.7	1.3	64.8%

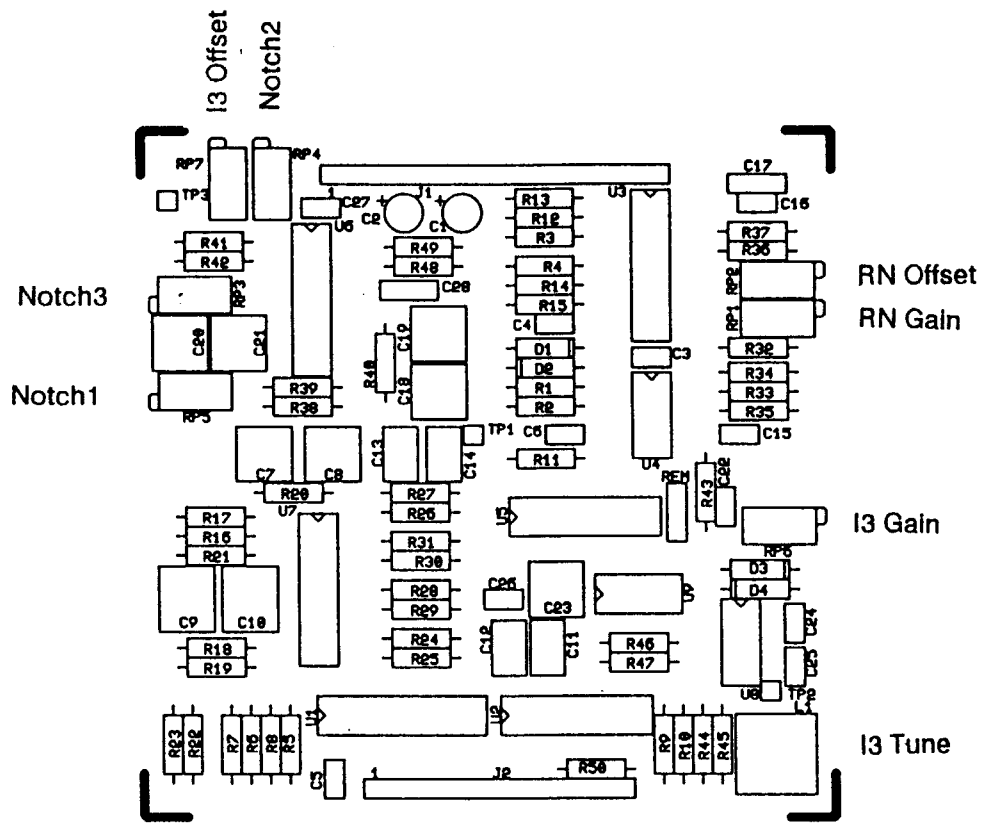
**Notes:** Calibration Data Files in directory CAL:

1. TEST444A = Disc SBC444A, entire disc.
2. CAL4446 = Disc SBC444A, track 6 only.
3. CAL5B3 = Disc 5B3, track 6 only.
4. CAL6D = Disc 6D, entire disc.
5. CAL6D6 = Disc 6D, track 6 only.
6. CAL6E = Disc 6E, entire disc.
7. CAL6E1 = Disc 6E, first two minutes only.
8. MPC6 = Disc MPC, track 6 only.
9. MPC10 = Disc MPC, track 10 only.
10. MPC14 = Disc MPC, track 14 only.
11. MPC16 = Disc MPC, track 16 only.
12. 5B3.DAT = Disc 5B jitter.
13. 6D.DAT = Disc 6D jitter.
14. 6E.DAT = Disc 6E jitter.

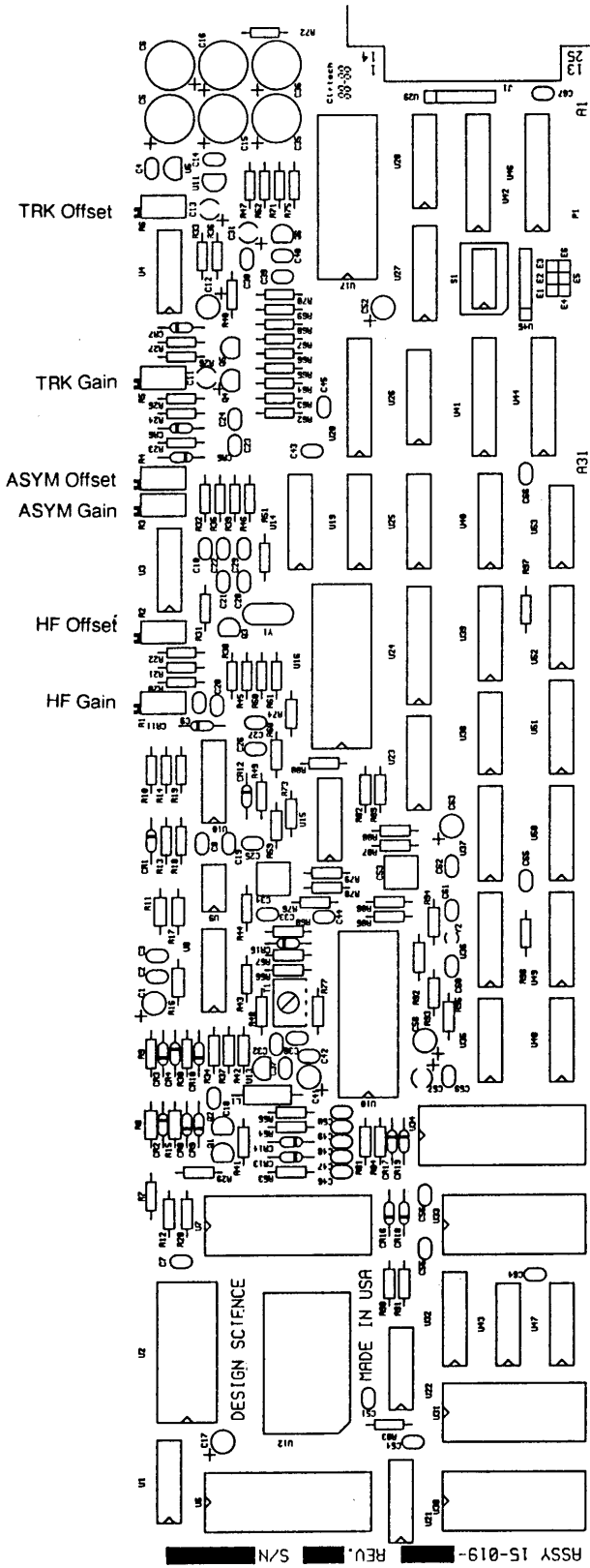


# APPENDIX D - LOCATION OF TRIMPOTS

Controls inside Player



DESIGN SCIENCE  
CD960 INTERFACE



LOCATION OF TRIMPOTS